HOOVER & KEITH INC. | ACOUSTICS & COMMUNICATIONS TECHNOLOGIES | 11381 MEADOWGLEN, SUITE I HOUSTON, TEXAS 77082 (281)496-9876 FAX (281)496-0016 | h&k

NASA Lewis Research Center

Audio Demonstration Compact Disc: Script for Male and Female Voice Talent

TRACK 1 – Description: Calibration Using a Sound Level Meter 0:35

FEMALE: For proper playback of these audio demonstrations, set your balance control to the center position, adjust tone controls for flat frequency response, and if you have a loudness compensation switch, set it to the "off" position.

MALE: If you do not have a sound level meter or if you are listening with headphones, proceed to track three. If you have a sound level meter, use the calibration tone on the next track to adjust the playback volume of your system. A sound level meter placed at the center of the listening area should read 70 decibels. Once the gain is set, do not adjust the playback level.

TRACK 2 – Calibration Tone (1 kHz, 70 dB, 30 sec) 0:30

TRACK 3 – Description: Calibration Using Conversational Speech 0:15

FEMALE: For listening with headphones or if a sound level meter is not available, the appropriate sound level can be approximated using speech. During the next track, adjust the playback volume of your system until the voices are reproduced at normal conversational speech levels.

TRACK 4 – About This Audio Demonstration Compact Disc 2:00

MALE: This compact disc contains a series of audio demonstrations that have been created to illustrate fundamental concepts in acoustics. The disc was produced by Hoover & Keith Inc. for the NASA Lewis Research Center for use in educational and community outreach activities and as a teaching aid for NASA Lewis Research Center and support service contractor hearing conservation programs.

FEMALE: The demonstrations on this disc will first help us explore our sensations of pitch and loudness as they relate to the measurable physical quantities of frequency and sound level.

MALE: Next, we will use electronic filtering techniques to analyze some familiar sounds for their frequency content to help convey various concepts associated with tonal and broadband spectra.

FEMALE: Finally, the effects of conductive and sensorineural hearing loss will be demonstrated by electronically filtering passages of spoken text and music to simulate progressive degrees of loss.

MALE: The playback level of this audio demonstration disc should be left unchanged after calibration. This may result in some sounds that are inaudible and other sounds that, while not hazardous, are loud enough to bother those around you if you are playing them over loudspeakers. Therefore, try to find a time and place that is quiet and away from people who might not want to hear these sounds.

TRACK 5 – Description: Low-Pitched Musical Sounds 0:25

MALE: The first dimension of sound that we will explore is "pitch." In this example, you will hear musical passages containing samples of low-pitched sounds. Low-pitched sound sources are typically large. Musical instruments such as the double bass, bass drum, and tuba are examples of low-pitched sound sources.

TRACK 6 – Example: Low-Pitched Musical Sounds 0:15

TRACK 7 – Description: High-Pitched Musical Sounds 0:25

High-pitched sound sources, like the musical instruments heard in this example, are smaller in size and include the violin, piccolo, and triangle.

TRACK 8 – Example: High-Pitched Musical Sounds 0:15

TRACK 9 – Description: Pure Tone, Middle C 0:40

MALE: A tone is perceived when a sound pressure wave repeats itself many times per second. The more rapid the repetition, the higher the pitch. The number of repetitions per second is called the frequency, for which the unit is the hertz. For instance, 100 hertz equals 100 repetitions per second. Most musical sounds are actually made up of a combination of frequency components, as we shall see in a later demonstration.

When the basic sound pressure pattern resembles a sine function, the wave is often called a "pure tone". Next you will hear a pure tone with frequency of 262 Hz, corresponding to middle-C.

TRACK 10 – Example: Pure Tone, Middle C 0:05

TRACK 11 – Description: Complex Tones, Middle C 0:20

MALE: Most of the tonal sounds we hear are actually complex sounds, made up of a specially organized collection of pure tones. The pure tones have frequencies that are whole-number multiples of a root frequency, called the "fundamental," which determines the pitch. The multiples of the fundamental frequency are called "harmonics". The relative strength of the harmonics is what determines the "timbre," or characteristic quality, of the sound. The timbre is the means by which we can tell instruments apart. In each of the next three examples, the pitch will be the same, but the timbre of each sound will be different. A triangle wave is heard first, so-called because of its appearance on an oscilloscope. A square wave and a sawtooth wave follow the triangle wave. As we will hear, the shape of the wave has a strong influence on its timbre.

TRACK 12 – Example: Complex Tones , Middle C 0:30

Example: Triangle Wave, Middle C

Example: Square Wave, Middle C

Example: Sawtooth Wave, Middle C

TRACK 13 – Description: Middle C Piano Tone Analysis 0:45

MALE: To demonstrate the frequency components of a complex musical sound, we will make use of a piano and some electronic filters. The piano will first sound middle C with no filtering. The same tone will then be played through a filter so that only the fundamental frequency of the sound is heard. Likewise, other filters will be used to isolate the second through the sixth harmonics of this same tone.

TRACK 14 – Example: Middle C Piano Tone Analysis 0:45

MALE: Middle C of the piano with no filtering:

MALE: Fundamental frequency, or first harmonic:

MALE: Second harmonic:

MALE: Third harmonic:

MALE: Fourth harmonic:

MALE: Fifth harmonic:

MALE: Sixth harmonic:

TRACK 15 – Description: Music in Octave Bands 0:35

MALE: When music is played, the sounds of the various instruments are spread throughout the audible range. In order to analyze such a broadband sound, we find it helpful to divide the audible frequency range into bands, much like splitting white light into a rainbow of colors with a prism. Instead of using a prism however, we use electronic filters with a width of one octave. The following sample consists of an orchestral music passage as heard through octave band filters. For the first few seconds, the passage will be heard normally without filtering. Then the music will sequence without interruption through eight octave-band filters centered at 63 hertz, 125 hertz, 250 hertz, 500 hertz, 1000 hertz, 2000 hertz, 4000 hertz, and 8000 hertz. The audible range actually extends another octave above and below the filtered samples presented: these are omitted because most sound systems are not capable of faithfully reproducing them. Finally, the music passage is heard again unfiltered.

TRACK 16 – Example: Music in Octave Bands 0:45

TRACK 17 – Description: Industrial Blower Sound in Octave Bands 0:20

MALE: In contrast to musical sounds, broadband sounds consist of a sequence of random wave patterns that do not repeat. Thus, they are usually perceived as “noise”. An industrial blower provides a good example of broadband noise. The blower is heard first without filtering, then filtered into the same eight octave-bands, then finally again without filtering. Listen how the different octave bands isolate parts of the total blower sound, such as the roar of the fan and the whine of the electric motor. Please note that this and other industrial sounds on this disc will be heard at levels below those normally encountered.

TRACK 18 – Example: Industrial Blower Sound in Octave Bands 0:45

TRACK 19 – Description: Water Knife Sound in Octave Bands 0:30

MALE: A water knife uses pressurized water to precisely cut steel and other materials. A high-pressure pump generates tones which are audible in the lower frequency bands, while the spray and impact of the water creates a broadband
“hiss” at higher frequencies. Note that although the tones each have a pitch, the result is not at all musical. In fact, the presence of tones generally makes a noise more annoying than it would otherwise be.

TRACK 20 – Example: Water Knife Sound in Octave Bands 0:45

TRACK 21 – Description: Supercomputer Sound in Octave Bands 0:15

MALE: The sound of a supercomputer is heard next. Important parts of this noise include the roar of the fan at low frequencies, the whine of the electric motor in the middle frequencies, and the scratching of the hard drive in the high frequencies.

TRACK 22 – Example: Supercomputer Sound in Octave Bands 0:45

TRACK 23 – Description: Jet Aircraft Takeoff and Landing, Broadband vs. Tonal 0:25

MALE: This example includes the sounds of a takeoff and landing of a jet aircraft at approximately 1000 feet distance. The takeoff is heard first followed by the landing. Notice how the sounds differ. On takeoff, low frequency "rumble" created by the jet blast dominates the sound. During landing, the tonal "whine" of the turbine compressors is most audible.

TRACK 24 – Example: Jet Aircraft Takeoff and Landing, Broadband vs. Tonal 0:30

MALE: Jet takeoff:

MALE: Jet landing:

TRACK 25 – Description: Industrial Sounds, Broadband vs. Tonal 0:15

MALE: This sample consists of three industrial sounds that present broadband noise and tonal noise in varying combinations. The first is a Steam Plant Boiler, the second a Laboratory Fume Hood, and the third a Jet Engine rollover.

TRACK 26 – Example: Industrial Sounds, Broadband vs. Tonal 0:30

MALE: Steam Plant Boiler:

MALE: Laboratory Fume Hood:

MALE: Jet Engine Rollover:

TRACK 27 – Description: 1 kHz Tone, 10 dB Steps 0:40

FEMALE: A second dimension of sound is its loudness, which is related to the amount of energy in the sound. When measuring using sound level meters, we express the amount of energy in decibels, or "dB." Here are a few things to keep in mind about decibels: 0 dB is the quietest sound that a normal-hearing person can hear, each increase of 10 dB means 10 times as much sound energy, and a 10-dB increase is usually judged as being twice as loud. The smallest or "just noticeable" difference in level is about 3 dB.

FEMALE: You will now hear a one thousand-hertz tone increasing in 10 dB steps from 45 dB to 85 dB.

<u>TRACK 28</u> – Sample: 1 kHz Tone, 10 dB Steps 0:15

<u>TRACK 29</u> – Description: Pink Noise, 10 dB Steps 0:20

FEMALE: We can perform the same demonstration using broadband noise. This sample consists of pink noise, a common audio testing signal, increasing in 10 dB steps from 45 to 85 A-weighted decibels, or dB(A). We will describe A-weighting in a later demonstration.

<u>TRACK 30</u> – Sample: Pink Noise, 10 dB Steps 0:15

<u>TRACK 31</u> – Description: Hearing Sensitivity vs. Frequency and Level 0:30

FEMALE: The following example consists of three presentations which allow us to compare our sensitivity to low and high frequency sounds at different sound levels. In each of the presentations, a sine wave will sweep across the audio range, followed by a 100-hertz tone and a 1000-hertz tone, all at a fixed electrical signal level. The signal level corresponds to 85 decibels for the first presentation, 70 decibels for the second presentation, and 55 decibels for the third presentation. Notice that at low levels the perceived loudness difference between low and high frequencies is more dramatic than at higher levels.

<u>TRACK 32</u> – Example: Hearing Sensitivity vs. Frequency and Level 0:35

FEMALE: 85 dB:

FEMALE: 70 dB:

FEMALE: 55 dB:

TRACK 33 – Description: Jet Aircraft Takeoff & Landing Sound, Linear vs. A-weight 1:00

FEMALE: A special feature incorporated into sound level meters to approximate the loudness sensitivity of the ear is the A-weighting filter. With the A-weighting filter switched in, the sensitivity of the sound level meter is reduced at low frequencies, similar to the response of the human ear at low levels of about 40 dB. It also happens that A-weighted sound levels are good predictors of hearing loss associated with repeated unprotected exposure to sound levels above 80 dB(A).

In the following example you will hear jet takeoff and landing sounds. They are presented first without filtering, then followed by the same sound processed through an A-weighted filter. The sounds that remain after A-weighting are those which have the most potential for hearing damage.

TRACK 34 – Example: Jet Aircraft Takeoff & Landing Sound, Linear vs. A-weight 0:10

FEMALE: Normal Takeoff:

FEMALE: A-weighted Takeoff:

FEMALE: Normal Landing:

FEMALE: A-weighted Landing:

TRACK 35 – Description: Industrial Sounds, Linear vs. A-weight 0:10

FEMALE: Next, you will hear industrial sounds presented first without filtering and then processed through an A-weighted filter. The sound levels for the presentations are typical but are reduced if they would have exceeded 85 dB(A).

TRACK 36 – Example: Industrial Sounds, Unweighted vs. A-weight 0:10

FEMALE: Unweighted Steam Plant Boiler:

FEMALE: A-weighted Steam Plant Boiler:

FEMALE: Unweighted Fume Hood:

FEMALE: A-weighted Fume Hood:

FEMALE: Unweighted Jet Engine Rollover:

FEMALE: A-weighted Jet Engine Rollover:

TRACK 37 – Description: Typical Sounds, 50 dB(A) – 85 dB(A) 0:30

FEMALE: In the following examples you will hear everyday sounds at typical levels. The sound of insects in a backyard is presented at 50 dB(A). Sound from the interior of an automobile traveling at 30 miles per hour is heard at 60 dB(A). Restaurant noises are presented at 70 dB(A). Sound from a vacuum cleaner at the operator position will be heard at 80 dB(A). The sound of a lawnmower is presented at 85 dB(A), although landscaping equipment sound levels often exceed 90 dB(A).

TRACK 38 – Example: Typical Sounds, 50 dB(A) – 85 dB(A) 0:30

FEMALE: Backyard insects, 50 dB(A):

FEMALE: Automobile interior at 30 miles per hour, 60 dB(A):

FEMALE: Restaurant noise: 70 dB(A):

FEMALE: Vacuum cleaner at Operator Position, 80 dB(A):

FEMALE: Lawnmower at Operator position, 85 dB(A):

TRACK 39 – Description: Audiometric Tones, 500 Hz – 8000 Hz, 60 dB 0:25

MALE: Repeated unprotected exposure to noise levels above 80 dB(A) may result in hearing loss. Noise-induced hearing loss is usually associated with reduction in hearing ability at the frequencies of 2000, 3000, and 4000 hertz. Audiologists and audiometric technicians use a standard set of tones to test for hearing loss: 500, 1000, 2000, 3000, 4000, 6000, and 8000 hertz. The tones are presented next at a level of 60 dB to illustrate their frequencies.

TRACK 40 – Example: Audiometric Tones, 500 Hz – 8000 Hz, 60 dB 0:30

MALE: 500 hertz:

MALE: 1000 hertz:

MALE: 2000 hertz:

MALE: 3000 hertz:

MALE: 4000 hertz:

MALE: 6000 hertz:

MALE: 8000 hertz:

TRACK 41 – Description: Conductive Hearing Loss with Speech 0:30

MALE: The hearing loss demonstrations that follow have been created using electronic filters to remove sound energy from spoken text in a manner that simulates hearing loss. Readings of two short stories will be used to illustrate progressive hearing loss and are intended to allow a normal-hearing person to temporarily experience sounds as a hearing-impaired person.

MALE: In this part of the hearing loss demonstration, we will hear examples of progressive conductive hearing loss. Conductive loss is usually associated with outer and middle ear problems and is due to causes unrelated to noise exposure. People with this type of loss usually have an overall reduction in hearing at all frequencies.

TRACK 42 – Example: Conductive Hearing Loss with Speech 1:40

MALE: Normal Hearing:

FEMALE: The Hound and the Hare

FEMALE: A hound startled a hare from his lair.

MALE: Conductive hearing loss of 10 decibels:

FEMALE: The hound chased the hare at top speed through meadows and woods. Finally, the exhausted hound gave up the chase.

MALE: Normal Hearing:

FEMALE: The hound chased the hare at top speed through meadows and woods. Finally, the exhausted hound gave up the chase.

MALE: Conductive hearing loss of 20 decibels:

FEMALE: A shepherd, after seeing the chase, said to the hound, "The hare is obviously the better runner."

MALE: Normal Hearing:

FEMALE: A shepherd, after seeing the chase, said to the hound, "The hare is obviously the better runner."

MALE: Conductive hearing loss of 30 decibels:

FEMALE: The hound replied, "You don't see the difference: I was only running for a dinner; he was running for his life."

MALE: Normal Hearing:

FEMALE: The hound replied, "You don't see the difference: I was only running for a dinner; he was running for his life."

<u>TRACK 43</u> – Description: Sensorineural Hearing Loss with Speech 0:10

MALE: Sensorineural hearing loss is associated with inner ear problems including those caused by the normal aging process, exposure to ototoxic chemicals and other substances, and repeated unprotected exposure to high noise levels. Noise-induced hearing loss affects the clarity and intelligibility of sound, which worsens as the loss spreads to more frequencies in the speech range. The following demonstrations will simulate the effects of progressive noise-induced hearing loss.

<u>TRACK 44</u> – Example: Sensorineural Hearing Loss with Speech 1:40

MALE: Normal Hearing:

FEMALE: <u>The Lion and the Mouse</u>

FEMALE: A lion was awakened from his sleep by a small mouse running over his face. Arising angrily, the lion caught the mouse and started to kill him.

MALE: Sensorineural hearing loss at 4000 hertz:

FEMALE: The mouse cried pitifully, "If you would only spare my life, I will someday repay your kindness." The lion laughed at the mouse to think that such a feeble creature could repay him, the king of the jungle.

MALE: Normal hearing:

FEMALE: The mouse cried pitifully, "If you would only spare my life, I will someday repay your kindness." The lion laughed at the mouse to think that such a feeble creature could repay him, the king of the jungle.

MALE: Sensorineural hearing loss above 2000 hertz:

FEMALE: The lion released the mouse who fled to the sound of the lion's laughter. A few days later, the mouse heard the lion's roar and followed the sounds to see what was wrong.

MALE: Normal hearing:

FEMALE: The lion released the mouse who fled to the sound of the lion's laughter. A few days later, the mouse heard the lion's roar and followed the sounds to see what was wrong.

MALE: Sensorineural hearing loss above 1000 hertz:

FEMALE: The lion had been trapped by hunters and was bound in thick ropes. The mouse gnawed through the ropes with his small sharp teeth and set the lion free.

MALE: Normal hearing:

FEMALE: The lion had been trapped by hunters and was bound in thick ropes. The mouse gnawed through the ropes with his small sharp teeth and set the lion free.

MALE: Sensorineural hearing loss above 500 hertz:

FEMALE: The mouse said, "You thought it was funny and ridiculous that I could repay your favor, but sometimes even a tiny, feeble mouse can help a great lion."

MALE: Normal hearing:

FEMALE: The mouse said, "You thought it was funny and ridiculous that I could repay your favor, but sometimes even a tiny, feeble mouse can help a great lion."

TRACK 45 – Description: Sensorineural Hearing Loss with Music 0:15

MALE: Our enjoyment of music is partly due to the ability to hear the rich timbres and textures of our favorite pieces. Sensorineural hearing loss diminishes this enjoyment by robbing us of the ability to hear certain frequency ranges. In the next track, orchestral music will be heard as is, then filtered to simulate increasing degrees of sensorineural hearing loss.

TRACK 46 – Example: Sensorineural Hearing Loss with Music 1:00

MALE: Normal hearing:

MALE: Sensorineural hearing loss at 4000 hertz:

MALE: Normal hearing:

MALE: Sensorineural hearing loss above 2000 hertz:

MALE: Normal hearing:

MALE: Sensorineural hearing loss above 1000 hertz:

MALE: Normal hearing:

MALE: Sensorineural hearing loss above 500 hertz:

MALE: Normal hearing:

MALE: Sensorineural hearing loss above 250 hertz:

MALE: Normal hearing:

TRACK 47 – Description: Hearing Protector Fitting 0:10

FEMALE: Three minutes of broad band noise at 85 dB(A) are provided on the following track to permit you the opportunity to practice fitting hearing protectors. If you are wearing headphones, skip to Track 49.

TRACK 48 – Example: Hearing Protector Fitting (Pink Noise, 85 dB(A)) 3:00

TRACK 49 – Description: Sounds of NASA Lewis Research Center 0:10

FEMALE: Examples of a variety of industrial sounds are provided on the following tracks. These sounds were recorded at NASA Lewis Research Center by TELARC International Corporation.

TRACK 50 – Example: Industrial Sounds 10:00

	TELARC DAT No.
Emission Spectrometer	2
Graphics Workshop Sign Cutter	3
Steam Plant	5
Power Plant Startup Sequence	7
Engine Components Lab	8
Mach 0.3 Burner Rig Room	11
Mach 0.3 Burner Rig Air Startup	12
Mach 0.3 Burner Rig Flame Test	13
Turboprop Aircraft Start Sequence	15
Rocket Test	18
Wind Tunnel Startup Sequence	24
Turret Punch	26
Brake Press	27
Riveter	29
Air Chisel, and	30
Grinder	31

End